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NOAA Technical Report NMFS SSRF—770

Population Characteristics of the American Lobster, *Homarus americanus*, in Eastern Long Island Sound, Connecticut

Milan Keser, Donald F. Landers, Jr., and
Jeffrey D. Morris

October 1983

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CONTENTS

Introduction 1
Materials and methods 1
Results and discussion 2
- Physical measurements 2
- Abundance and catch per unit effort 2
- Size frequencies 3
- Sex ratios 4
- Growth 5
- Berried females 5
- Culls 5
- Molting patterns 5
- Gear effectiveness 6

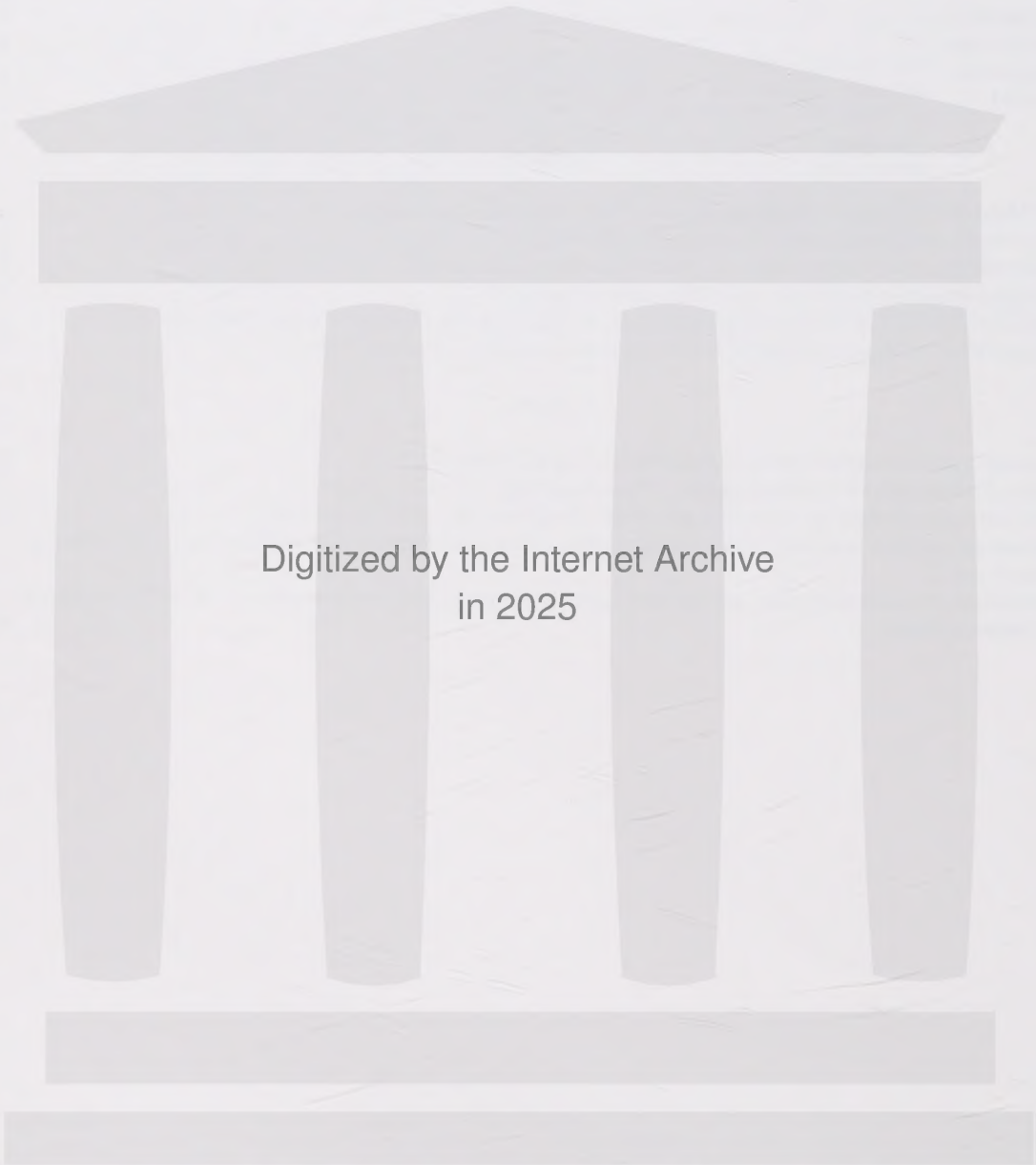
Acknowledgments 6
Literature cited 6

Figures

1. Map of Millstone Point area showing the location of the lobster sampling stations 1
2. Monthly lobster catch per unit effort for wood pots 1976-81 3
3. Catch per unit effort and bottom water temperature for each station based on 1979 data 3
4. Annual size distribution of lobsters in the Millstone Point area, 1975-77 4
5. Annual size distribution of lobsters in the Millstone Point area caught in wood and wire pots, 1978-81 4
6. Molting patterns for lobsters in the Millstone Point area based on data from 1975 to 1981 5

Tables

1. Mean monthly surface and bottom water temperature at each station (1979-81) 2
2. Summary of lobster mark-recapture program, 1975 through 1981 2
3. Monthly catch per unit effort for wood and wire pots from 1978 to 1981 at Millstone Point 3
4. The percentage, number, size range, and mean carapace length of egg-bearing females collected from 1975 to 1981 at Millstone Point 5
5. The percentage of catch missing one claw, two claws, and total percent cull for both wood and wire pots from 1975 to 1981 at Millstone Point 5



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Population Characteristics of the American Lobster, *Homarus americanus,* in Eastern Long Island Sound, Connecticut

MILAN KESER, DONALD F. LANDERS, JR., and JEFFREY D. MORRIS[2]

ABSTRACT

Population characteristics of the American lobster have been studied extensively in the vicinity of Millstone Point, Conn. Since 1975, 22,150 lobsters have been tagged, and pertinent biological data recorded. Catch per unit effort was similar among years, but was significantly higher for wire than wooden pots. Legal-sized individuals ranged from 4.5 to 18.1% of the total catch. The percentage of culled lobsters ranged from 9.7 to 17.4%, and was greater for wood than wire pots. The sampled population was comprised of 51% males and 49% females. Berried females accounted for 3.1-6.7% of the total catch, and over half of these were of sublegal size. Growth per molt averaged 13.0% and was not significantly different between sexes. A major period of molting occured in the late spring and early summer.

INTRODUCTION

The American lobster, *Homarus americanus,* has been studied extensively throughout much of its range (Cobb and Phillips 1980a,b). Quantitative investigations of lobster populations within Long Island Sound (LIS) have begun only in the past 10 yr. Stewart (1972) studied the ecology of lobsters in the vicinity of Fisher's Island Sound; Lund et al. (1973)[3] inventoried lobster habitats and gathered data on movements throughout LIS; Smith (1977)[4] described population characteristics in LIS and socioeconomic aspects of the commercial fishery along the Connecticut coast; Briggs and Mushacke (1979) published results of a 3-yr study on selected population characteristics of lobsters in western LIS. The present study is part of a larger monitoring program at the Millstone Nuclear Power Station (MNPS) and is the first long term investigation of a lobster population in the eastern portion of LIS, representing results from 1975 to 1981.

This study was designed to assess the potential impact of construction and operation of MNPS on the local lobster population. Data on catch per unit effort, size frequencies, sex ratios, growth rates, incidence of berried females, number of culls, molting patterns, and gear effectiveness are presented here. These parameters are compared year to year, seasonally, between stations, and with data reported throughout northeastern North America.

MATERIALS AND METHODS

The study area is located in Waterford, Conn., adjacent to MNPS (Fig. 1). The power station includes two operating nuclear reactors and a third under construction. Unit 1 is a 652 MWe reactor and has operated since November 1970. Unit 2 is a 850 MWe reactor operating since October 1975. The third reactor will be 1,150 MWe, and is scheduled for commercial operation in 1986.

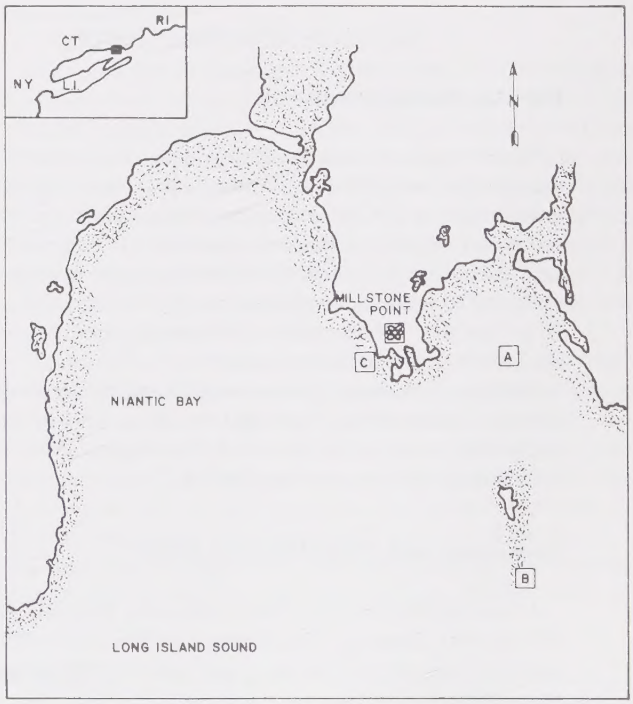

Figure 1.—Map of Millstone Point area showing the location of the lobster sampling stations (A-Jordan Cove, B-Twotree, C-Intake).

[1]Northeast Utilities Environmental Laboratory, P.O. Box 128, Waterford, CT 06385.

[2]Northeast Utilities Environmental Laboratory, P.O. Box 128, Waterford, Conn.; present address: Biometric Unit, Cornell University, Ithaca, NY 14853.

[3]Lund, W. A., L. L. Stewart, and C. J. Rathbun. 1973. Investigation on the lobster. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Commer. Fish. Res. Dev. Act, Project No. 3-130-R, 189 p.

[4]Smith, E. M. 1977. Some aspects of catch/effort, biology, and the economics of the Long Island Sound lobster fishery during 1976. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Commer. Fish. Res. Dev. Act, Project No. 3-253-R-1, 97 p.

Suitable lobster habitats in the vicinity of MNPS (6.5 km²) are characterized by rocky outcrops interspersed with patches of hard sand.

Beginning in January 1975, lobsters were sampled from natural and artificial habitats using scuba, from fish trawls, and from impingement studies at Units 1 and 2 intake structures. In September, 20 double entry wooden lobster pots (91 x 51 x 30 cm; 3-5 cm lath space) were set at each of three stations (Fig. 1): Jordan Cove, (east of Millstone Point; 500 m from discharge) Intake, (along the western shore of Millstone Point near the power plant intake structures; 600 m from discharge) and Twotree (1,600 m offshore, near Twotree Island). Year round sampling continued until November 1978. Subsequently, the sampling period was reduced to the months of high catch, May-October. In August 1978, half of the wood pots (10 per station) were replaced with commercial vinyl coated wire pots (76 x 51 x 30 cm; 2.5 cm² mesh).

Throughout the study, pots were hauled on Monday, Wednesday, and Friday, weather permitting. At each station, lobsters were removed from traps, claws restrained with rubber bands, and pots rebaited. Prior to 1979, an assortment of locally caught fish was used as bait; subsequently, to standardize the effect of bait on catchability, flounder carcasses were used exclusively. Carapace length (CL), sex, presence of eggs (berried), missing claws, and molt stage were reported for each lobster captured.

Molt stage was determined using criteria established by Aiken (1973). Recaptured tagged lobsters, severely injured individuals, and those < 55 mm CL were returned to the water untagged. All others were returned to the laboratory and maintained in continuous flow saltwater tanks, segregated by station and pot type. Each Friday, all lobsters were tagged with a numbered international orange sphyrion tag (Scarratt and Elson 1965; Cooper 1970; Scarratt 1970), and returned to the site of capture.

From 1979 to 1981, during each sampling trip, surface and bottom water temperatures and salinities were recorded at each station with a Beckman salinometer.

RESULTS AND DISCUSSION

Physical Measurements

Water temperature and salinity were measured from May through October (1979-81). Bottom temperatures ranged from 7°C in early May to 22°C in summer, and were up to 2.1°C lower than corresponding surface temperatures (Table 1). Temperatures (surface and bottom) at Jordan Cove and Intake (4-6 m in depth) were similar to each other, but slightly warmer than at Twotree (12 m). At present (two unit operation), the thermal plume does not reach the bottom sediments at any station.

Salinity was constant between stations and between surface and bottom; values ranged from 29.1 to 32‰. Due to the spring freshwater runoff, salinities were 1.2‰ lower in May and June than in the rest of the sampling period.

Abundance and Catch Per Unit Effort

A total of 27,019 lobsters were collected in the study area from 1975 to 1981 (Table 2). The increased catches from 1978 to 1981 were the result of the addition of wire pots into the sampling program (Table 3).

Catch per unit effort (CPUE) for wood pots was similar in magnitude from 1976 to 1981, but peaked at different times within each year (Fig. 2). At temperatures > 10°C lobster catch began to increase at Jordan Cove and Intake and peaked between 15° and 20°C (Fig. 3). However, at Twotree (our deep station), the catch was highest between 7° and 15°C. Since catches at Twotree decreased concurrently with increases at Jordan Cove and Intake, the movement of lobsters from Twotree into our inshore stations may have been the cause of the increased inshore catch; however, preliminary data on interstation movements do not support this hypothesis (NUSCo 1979, 1980)[5]. The relationship between catch and water temperature has been reported by other researchers (McLesse and Wilder 1958; Dow 1966, 1969, 1976; Flowers and Saila 1972).

Results from the 1978-80 sampling period indicated that wire pots caught significantly more lobsters than did wood pots (Table 3); however, this was not the case in 1981. The wire pots used in

Table 1.—Mean monthly surface (S) and bottom (B) water temperature (°C) at each station (1979-81).

Month	Jordan Cove S	Jordan Cove B	Intake S	Intake B	Twotree S	Twotree B
			1979			
May	10.3	9.5	10.5	9.5	9.9	9.2
June	15.0	14.2	15.2	14.4	14.5	13.9
July	19.9	17.8	19.2	18.3	18.3	17.7
August	20.6	19.6	20.2	19.8	19.7	19.2
September	19.8	19.2	19.8	19.3	19.2	18.9
October	17.0	15.9	15.8	15.7	15.6	15.5
			1980			
May	10.8	9.8	10.6	9.7	9.9	9.4
June	14.8	14.1	14.7	14.3	14.4	13.9
July	19.6	17.8	19.2	18.3	18.4	17.7
August	21.2	19.9	21.0	20.1	20.2	19.7
September	20.7	19.8	20.5	20.0	20.1	19.9
October	16.1	15.9	16.1	16.0	16.2	16.1
			1981			
May	9.8	9.0	9.6	9.1	9.3	8.8
June	16.0	14.1	15.3	14.6	14.6	14.0
July	19.9	19.0	19.8	19.2	19.3	18.6
August	21.8	20.5	21.2	20.7	20.6	20.3
September	20.4	19.5	19.8	19.6	19.7	19.4
October	15.2	14.6	14.7	14.5	14.2	14.1

Table 2.—Summary of lobster mark-recapture program, 1975 through 1981.

Sampling period Months	Year	Number caught	Number tagged	Recaptures N	Recaptures %
Sept.-Dec.	1975	1,501	1,501	97	6.5
Jan.-Dec.	1976	3,498	2,962	341	11.5
Jan.-Dec.	1977	3,242	2,876	240	8.3
Jan.-Dec.	[1]1978	4,371	3,199	378	11.8
May-Oct.	1979	5,031	3,732	674	18.1
May-Oct.	1980	4,266	3,634	485	13.3
May-Oct.	1981	5,110	4,246	571	13.4
Total		27,019	22,150	2,786	12.6

[1]Wire pots added to sampling scheme in August.

[5]NUSCo. 1979. Lobster population estimates. *In* The annual report on ecological and hydrographic studies at the Millstone Nuclear Power Station, p. E1-E27. Northeast Utilities Service Co., Waterford, Conn.
NUSCo. 1980. Lobster population dynamics. *In* The annual report on ecological and hydrographic studies at the Millstone Nuclear Power Station, p. 195-231. Northeast Utilities Service Co., Waterford, Conn.

Table 3.—Monthly catch per unit effort (catch/100 pots hauled) for wood and wire pots from 1978 to 1981 at Millstone Point.

	Total catch		Legal catch	
	Wood	Wire	Wood	Wire
		1978		
August	55	215	8	18
September	96	177	14	19
October	54	132	8	15
November	98	162	16	12
		1979		
May	86	132	6	6
June	103	183	18	15
July	124	195	23	25
August	95	164	15	12
September	69	151	10	9
October	55	112	9	9
		1980		
May	79	180	15	15
June	65	170	14	12
July	69	177	18	17
August	56	131	13	12
September	69	84	12	8
October	78	74	6	3
		1981		
May	118	134	8	8
June	153	116	15	8
July	157	124	21	13
August	122	100	13	11
September	122	73	11	10
October	112	66	13	9

1981 had a slightly different parlor entry funnel than those used in previous years, and apparently did not trap lobsters as effectively. An experiment to test this is underway; preliminary data indicate that slight changes in parlor head design can greatly affect trap efficiency. Similarly, Spurr (1972)[6] reported that the principal factor affecting pot efficiency was parlor head design, and Thomas (1959) found that the high-rigged heads deterred escape.

[6]Spurr, E. W. 1972. Lobster research project: Final report of 3-105-R, July 1969-June 1971. N.H. Fish Game Dep., Fish. Div., Concord, N.H., 22 p.

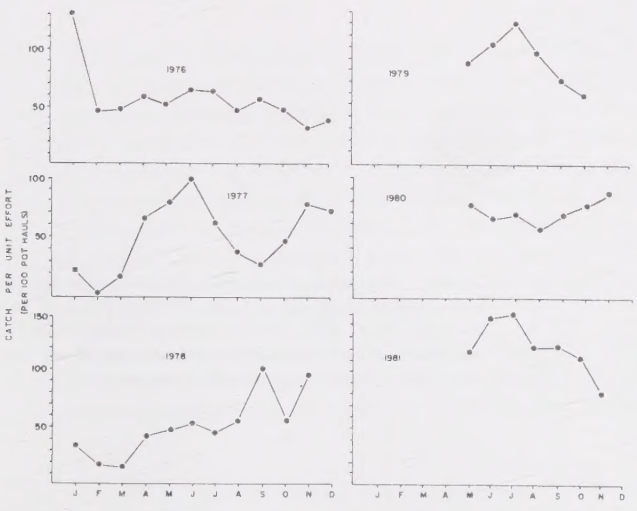

Figure 2.—Monthly lobster catch per unit effort (per 100 pot hauls) for wood pots 1976-81.

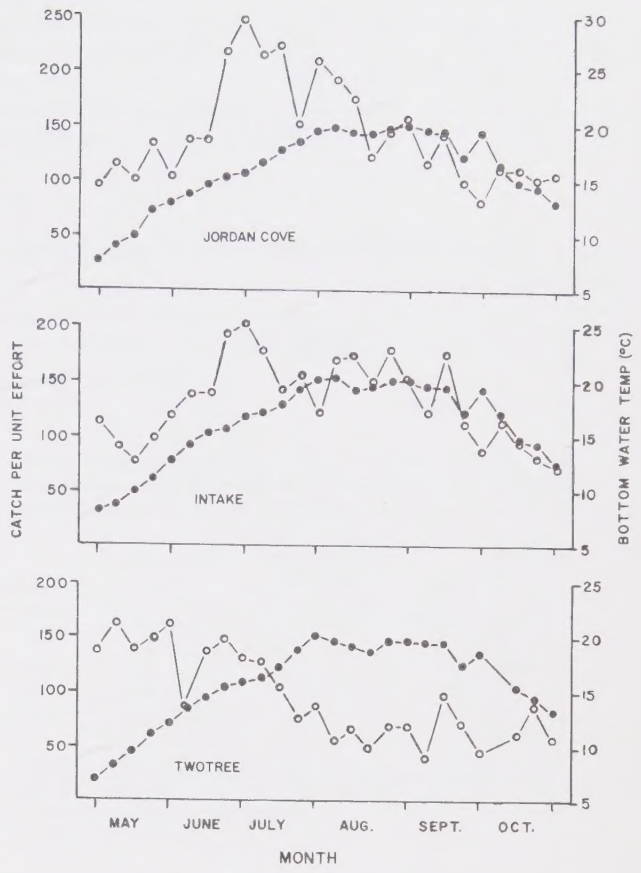

Figure 3.—Catch per unit effort (open circles) (per 100 pot hauls) and bottom water temperature (solid circles) for each station based on 1979 data.

Size Frequencies

The yearly size distributions of lobsters caught in the Millstone Point area from 1975 to 1981 are presented in Figures 4 and 5. The relatively larger proportion of smaller sized individuals in 1975 was attributed to sampling methodology. During 1975, lobsters were acquired from artificial habitats using scuba, from fish trawls, and from impingement studies at Units 1 and 2 intake structures. Subsequently, lobsters were captured using commercial pots, which do not sample small individuals as effectively. Pecci et al. (1978) reported that lobsters in surface-hauled pot catches were larger than ones caught by divers.

Since lobsters have been collected using wood pots, yearly mean carapace length and percent legal catch have not varied greatly. From 1976 to 1981, average CL ranged from 73.3 to 76.6 mm. Two other investigations within LIS that used wood pots found larger lobsters: mean CL of 78.9 mm was reported by Smith (footnote 4) for an area east of the Connecticut River, and 78.2 mm was reported for western LIS (Briggs and Mushacke 1979). Our study also used wire pots since 1978, and yearly mean CL for these traps ranged from 70.9 to 71.5 mm. Marcello et al. (1979)[7], using wire

[7]Marcello, R. A., Jr., W. Davis III, T. O'Hara, and J. Hartley. 1979. Population statistics and commercial catch rate of American lobster (*Homarus americanus*) in the Charlestown-Matunuck, Rhode Island region of Block Island Sound. Submitted to New England Power Company, YAEC1175, 40 p. Yankee Atomic Electric Company, 20 Turnpike Road, Westboro, MA 01581.

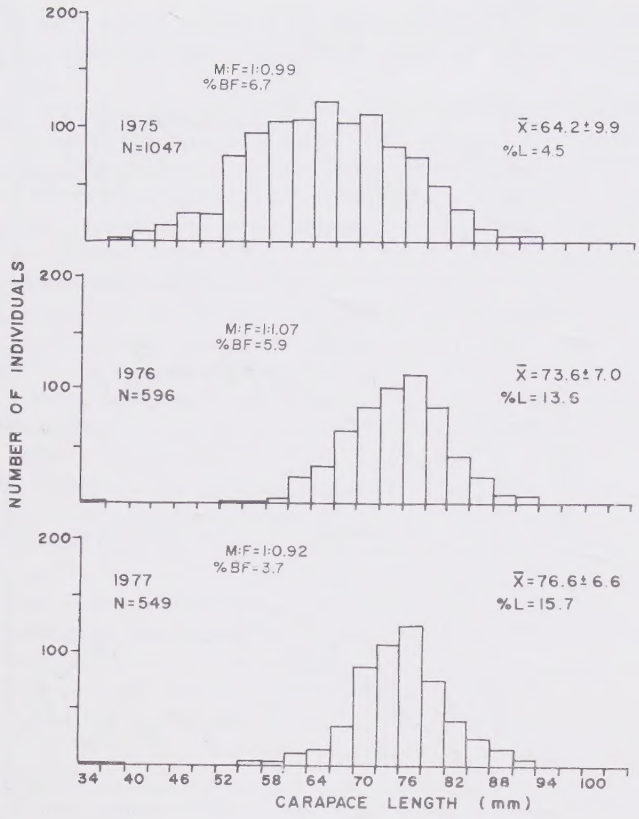

Figure 4.—Annual size distribution of lobsters in the Millstone Point area, 1975-77 (wood pots). Values for male:female sex ratios (M:F), percent of berried females (% BF), mean carapace length ($\bar{X}$), and percent legal catch (%L) are also presented.

pots (2.5 cm² mesh) in Block Island Sound (BIS), calculated an average CL of 74 mm.

The percent of legal-sized (CL ≥ 81 mm) individuals in our catch ranged from 7.2 to 18.1% (1976-81). The values reported by other area investigators range between 16.7 and 34.0% (Smith footnote 4; Briggs and Mushacke 1979; Marcello et al. footnote 7). Over 92% of the legal-sized lobsters in our study were newly recruited from the sub-legal class (assuming 13% growth per molt).

Our study area has a higher proportion of small lobsters and a smaller proportion of legal-sized individuals than has been reported from surrounding areas. Over 75% of the legal-sized individuals that we tagged and released were subsequently caught by commercial fishermen, and removed from the population. These data attest to the high exploitation of the local lobster population, especially in the summer when recreational fishing increases. Availability of shelters and physical habitat characteristics appear to be the primary naturally occuring limiting factors (excluding the physical parameters of temperature, salinity, and oxygen) of lobster populations (Phillips et al. 1980).

Sex Ratios

Since 1975, the yearly mean sex ratio of males to females was close to 1:1 (Figs. 4, 5). However, when three stations were compared, Twotree had consistently higher proportions of females, whereas Intake and Jordan Cove had slightly more males. Sex ratios close to 1:1 were also reported by other researchers working in nearshore waters (Herrick 1909; Templeman 1936; Ennis 1971, 1974; Stewart 1972; Krouse 1973; Thomas 1973; Cooper et al. 1975; Briggs and Mushacke 1980). However, Smith (footnote 4), working in four different areas of LIS, found male to female ratios ranging from 1:1.06 to 1:1.81. Dominance of females in the catch

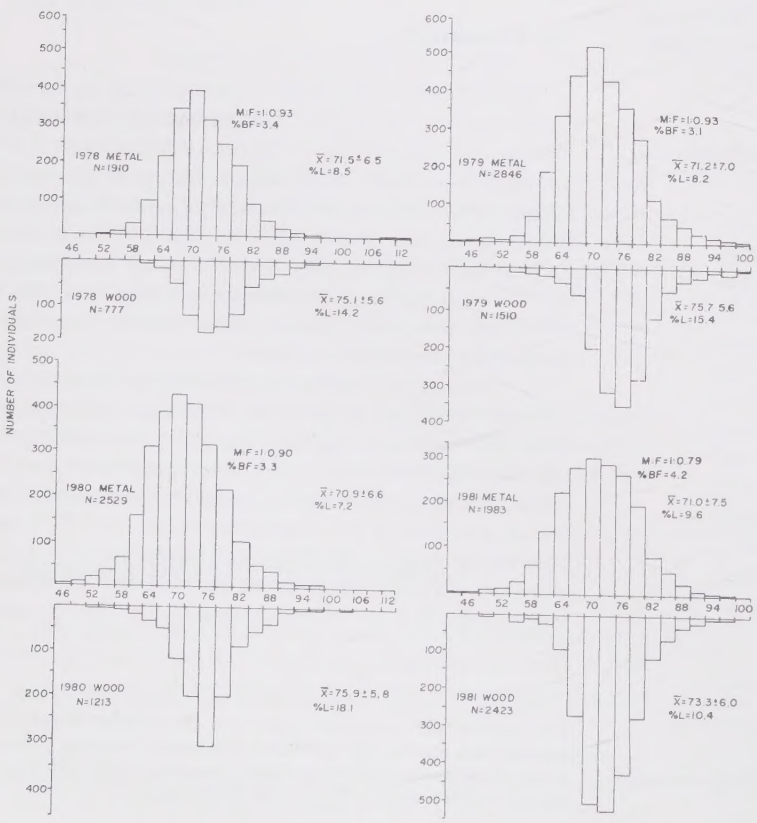

Figure 5.—Annual size distribution of lobsters in the Millstone Point area caught in wood and wire pots, 1978-81. Values of male:female sex ratios (M:F) and percent of berried females (%BF) represent combined pot type data. Mean carapace length ($\bar{X}$) and percent legal catch (%L) values are presented for each pot type.

was also reported by Marcello et al. (footnote 7) and by Briggs and Mushacke (1979). Variability in the sex ratios of lobsters is often associated with size composition of the catch, which is affected by sampling methods and depth of water (Ennis 1980). Ratios close to 1:1 occur up to the size at which females are sexually mature, after which females tend to predominate in the catch (Skud and Perkins 1969; Ennis 1980).

Growth

As a result of the mark and recapture tagging program, growth expressed as percent increase in carapace length between molts was calculated for 270 individuals that molted between the time of release and the time of recapture. The growth per molt ranged from 12.1 to 13.4% (1978-81). There was no significant difference in growth between males and females. Stewart (1972) reported growth per molt of 15.8% for males and 15.4% for females from eastern LIS and Briggs and Mushacke (1979) reported 10.4% from western LIS. In inshore waters, growth per molt has been reported from 12.0 to 17.5% (Wilder 1953; Cooper 1970; Ennis 1972; Fair 1977[8]). Cooper and Uzmann (1971) found growth increments of 16.7% for females and 18.7% for males caught in deep offshore waters. Smaller growth of inshore lobsters is attributed to their relative inactivity (feeding) during the colder months of the year (Cooper and Uzmann 1980).

Berried Females

From 1975 to 1981, the percentage of females that were bearing eggs ranged from 3.1 to 6.7% (Table 4). However, the 1975-76 values were based on small sample sizes so the 1977-81 values of about 3% are more representative. Twotree had a significantly ($P < 0.05$) greater proportion of berried females of the three stations (Duncan's Multiple Range Test), and this was attributed to shelter availability and water depth. Other investigators in eastern LIS and BIS have reported percentages of berried females ranging from 2.5 to 8.2% (Stewart 1972; Smith footnote 4; Marcello et al. footnote 7). These values differ considerably from those in western LIS, where Smith (footnote 4) reported 27.3% and Briggs and Mushacke (1979) 27.8% of females berried.

Table 4.—The percentage, number, size range, and mean carapace length (CL) ± SD of egg-bearing females collected from 1975 to 1981 at Millstone Point.

Year	Intake	Jordan Cove	Twotree	Overall	*N*	Range	CL
[1]1975	3.5	4.5	9.7	6.7	7	73-84	79.1 ± 3.7
1976	3.3	1.9	11.2	5.9	16	70-102	82.9 ± 7.7
1977	3.5	1.4	6.2	3.7	35	68-92	79.7 ± 6.4
[2]1978	2.8	1.7	5.4	3.4	58	74-88	80.1 ± 4.0
1979	2.8	1.7	5.2	3.1	67	64-93	80.6 ± 5.4
1980	1.8	2.8	5.0	3.3	71	72-93	79.2 ± 5.1
1981	2.6	1.6	6.7	4.2	82	70-97	81.2 ± 6.1

[1]Wood pots only (1975-77).
[2]Wood and wire pots (1978-81).

The mean CL of berried females in our study ranged between 79.1 and 82.9 mm. Other investigators in our area reported average sizes of berried females from 80.0 to 86.2 mm. The smallest berried female caught during our study was 64 mm CL and was smaller than has been reported by any of the area investigators. Female lobsters in LIS and BIS apparently mature at a smaller size than those off the coast of Maine (Krouse 1973; Thomas 1973), the outer shelf (Skud and Perkins 1969), and the south shore of Long Island (Briggs and Mushacke 1980).

Culls

The percentage of culled lobsters (missing either one or both claws) has ranged from 9.7 to 17.4% (Table 5). Smith (footnote 4) reported 26.4% culled in LIS, east of the Connecticut River, and Briggs and Mushacke (1979) reported culls varying between 7.4 and 22.8% in western LIS.

Table 5.—The percentage of catch missing one claw, two claws, and total percent cull for both wood and wire pots from 1975 to 1981 at Millstone Point.

	Percent missing one claw		Percent missing two claws		Percent cull	
Year	Wood	Wire	Wood	Wire	Wood	Wire
1975	7.8	—[1]	1.9	—	9.7	—
1976	13.5	—	2.0	—	15.4	—
1977	10.4	—	1.2	—	11.7	—
1978	14.1	14.0	1.9	0.9	15.9	15.0
1979	15.0	14.4	2.4	1.2	17.4	15.5
1980	14.7	11.9	2.2	1.4	16.9	13.4
1981	12.6	11.2	1.4	0.9	14.0	12.1

[1]Wire pots not used.

Percent culled in wood pots (range 14.0-17.4%) was slightly greater than that observed in wire pots (range 12.1-15.5%), 1978-81. Trap related injuries resulting in claw loss are often associated with water temperature, fishing pressure (i.e., handling by lobstermen), trap set over days, and physical condition of the lobster (i.e., its nearness to molt; Pecci et al. 1978).

Molting Patterns

Molting was first noted in May, although at low levels (< 1%) (Fig. 6). Incidence of molters reached a peak in June (6-8%), coin-

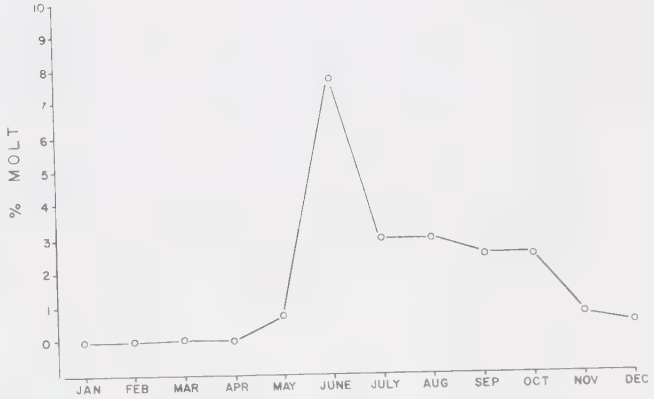

Figure 6.—Molting patterns for lobsters in the Millstone Point area based on data from 1975 to 1981.

[8]Fair, J. J., Jr. 1977. Lobster investigations in management area I; Southern Gulf of Maine. Mass. Div. Mar. Fish., Contract No. 03-5-043-328, 8 p. Fish. Manage. Branch, State-Fed. Relationships Div., Natl. Mar. Fish. Serv., NOAA, State Fish Pier, Gloucester, MA 01930.

ciding with bottom water temperatures of 14°-16°C. Subsequently, molting continued at a low level (1-4%) from July to October and ceased in January. The variability of incidence of molting among stations and years made it difficult to discern a distinct peak occurring in autumn, as indicated by Lund et al. (footnote 3) for LIS, and by Russell et al. (1978)[9] for Narragansett Bay. A single molting peak per year has been described in Maine and in offshore waters (Dow 1966; Skud and Perkins 1969; Krouse 1973).

Gear Effectiveness

An important objective of this study was to gather information on as large a segment of the local lobster population as possible. Through the use of wire pots (2.5 cm^2 mesh) we anticipated increased catch of smaller sized lobsters capable of escaping through the 3-5 cm gap between the laths of the commercial wood pots. A Kolmogorov-Smirnov test on the size distribution of lobsters caught in the two pot types indicated that wire pots caught significantly ($P < 0.05$) more of the < 75 mm CL size class than did the wood pots. These results are similar to those of Krouse (1973) who found that CL of the catch from wire pots averaged between 67.9 and 70.5 mm. He considered the modal size of his catch (70 mm CL) to be the size at which lobsters are less apt to escape the traps; using the same reasoning, lobsters in our study are vulnerable to the wire pots at 70 mm CL and to the wood pots at about 76 mm CL. Lobsters of 70-76 mm CL are important, since these individuals constitute a large proportion of the prerecruits (i.e., those individuals within one molt of legal size). The lobster population of the Millstone Point region is subjected to a high exploitation rate. The size of the legal catch is therefore largely determined by these prerecruit size classes.

Some factors to consider in the selection of lobster pots include the cost, the catch efficiency, the ease of handling, the expected life of the trap, and its susceptibility to storm loss. Wire pots caught more lobsters, were more easily hauled, required less maintenance, and were capable of fishing effectively up to 3 yr. Wood pots allowed escapement of smaller lobsters, required more ballast, travelled through the water slowly thus requiring more effort to haul, and could only be fished for one season (< 1 yr) because of wood borer attack. There was no significant difference (ANOVA $P < 0.05$) between the CPUE of legal-sized lobsters caught in wood and wire pots. However, wood pots caught more legal-sized lobsters in 3 of 4 yr (Table 3).

In conclusion, the lobster population of the Millstone Point region has remained stable since 1976. The values for size structure, sex ratios, growth rates, number of berried females, incidence of culled lobsters, and molting patterns of our catch, are within ranges reported throughout northeastern North America. Results indicated that the local population was highly exploited with the commercial and recreational catch (≥ 81 mm CL) being highly dependent on the prerecruit size class. The seasonal variation in catch was shown to be a function of molting patterns and changes in catchability, induced by the seasonal change in water temperature. No power plant induced change in water temperature was observed at any station, and any power plant induced effect (if any) on lobster population parameters cannot be distinguished from naturally occurring variability.

[9]Russell, H. J., D. V. D. Borden, and M. J. Fogarty. 1978. Management studies of inshore lobster resources completion report. R.I. Fish Game L074-1-RI(1):1, 75 p.

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